PLC Based Power Distribution Control System in Aksum University

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Abstract

This paper deals with PLC based Electric power distribution control system which is an important part of electrical power systems in delivery of electricity to consumers. PLC in the distribution field allows utilities to implement flexible control of distribution systems, which can be used to enhance efficiency, reliability, and quality of electric service. Presently research and development efforts are focused in the areas of Aksum university revolution and application in the distribution automation to make distribution automation more intelligent, efficient and cost effective. This paper presents brief overview about the power distribution and transmission automation system. The application areas, advantages and commercially available products for the distribution system automation are also described in detail. It also discusses about the present implementation and current challenges in the distribution system automation.

There are several reasons why we need power distribution automation systems or plc based power distribution control system. These reasons are problems which are faced due to human control system in Aksum University those are less reliable in efficiency, more power consumption, high cost effect, less quality and unsafely operation and faults such as over voltage fault, under voltage fault, over current fault, under current fault, over temperature fault, phase to phase fault and phase to ground that exist in power distribution system in AKU at every block is difficult to control by somebody (operator). Therefore, we have designed plc based power distribution control system to solve these problems which are explained above.

1. Introduction

The word Automation means doing the particular task automatically in a sequence with faster operation rate. This requires the use of PLC together with communication network and some relevant software programming. Application of automation in distribution power system level can be defined as automatically monitoring, protecting and controlling switching operations through intelligent electronic devices to restore power service during fault by sequential events and maintain better operating conditions back to normal operations. Now a day due to advancement in the communication technology, distribution automation system (DAS) is not just a remote control and operation of substation and feeder equipment but it results into a highly reliable, self-healing power system that responds rapidly to real-time events with appropriate actions. Hence, automation does not just replace manual procedures; rather it permits the power system to operate in best optimal way, based on accurate information provided in a timely manner to the decision-making applications and devices. Distribution Automation Systems have been defined by the Institute of Electrical and Electronic Engineers (IEEE) as systems that enable an electric utility to monitor, coordinate, and operate distribution components in a real time mode from remote locations.

There are several reasons why we need distribution automation systems. Until now, the electric power industry has made remarkable progress in both quantity and quality. But, it is expected that social demand for better services would be requested. The main function of DAS is the programmable control of switches to locate, isolate the fault and restore the service, when a fault occurs in the power distribution line. Now, distribution automation has to address enhancements in efficiency as well as reliability and quality of power distribution. Today utilities are more concerned about improving reliability due to the implementation of performance based rates and improving power quality due to its impact on sensitive loads. Further, Specific tools that need attention for implementation of AKU distribution automation (ADA) include tools for

cost/benefit evaluation, system analysis, and reliability evaluation.

2. Statement of problem

We observe problems which are faced due to human control system in Aksum University those are less reliable in efficiency, more power consumption, high cost effective, less quality and unsafely operation and faults such as over voltage fault, under voltage fault, over current fault, under current fault, over temperature fault, phase to phase fault and phase to ground that exist in power distribution system in AKU at every block is difficult to control by somebody (operator). Therefore, we have design plc based power distribution control system to solve these problems which are explained above.

In the current highly competitive educational environment, the institution is challenged by the demand for productivity, quality, safety and environmental protection. Information technology in achieving these goals has become critical. Large and complex production systems cannot be efficiently and safely managed without advanced information management and process control. End users expect to get improved functionality at reasonable cost. Management of knowledge and real-time information, integration with condition monitoring and plant maintenance, high availability, flexible upgrades and life-cycle support are examples of key requirements. System integrators need efficient tools for building applications. Manufacturers face the challenge of satisfying customer's needs while still maintaining a sound and profitable product structure in a rapidly changing technical environment.

3. Methodology

There are few stages that will be involved in order to work out the aimed objectives in this project. The project was beginning by discussion the project with our advisor. After finding right objectives, problem and other related issues, the finding is done doing some literature review. After that the project development is begin. The project is divided in to two parts which are hardware and software development. The hardware part includes the different types of input sensors and the output parts like relay, circuit breaker, LCD. The software we used is programmable logic controller using ladder logic programming. The flow chart for this project development is expressed as:

In this chapter, the specific methodology for every project scope and objective are elaborated step by step modifying, explaining and emphasizing the details of methods applied. Here, the block diagrams and flowcharts related to each objective or scope are also elaborated and revealed. The power distribution in AKU has six power house such as 1250kva (two), 315kva (two) and 630kva (two) can be used in the distribution system. That distribution can be operated in manually so we can improve by plc based control system. The maximum power house is 1250 kva if one is programmed the rest are possible to programmed similarly, so we select the maximum kVA to our project. The maximum voltage is 400v without loss, the minimum is 400v*power factor (0.8) the minimum is 380v. To find maximum current

I=KVA *1000/E*1.73

=1250KVA*1000/15000*1.73

=48.11KA this is the maximum

The minimum is=48.11ka*0.8=38.49KA

4. Block diagram

The overall block diagram below shows the connection of PLC with its input sensors and output.

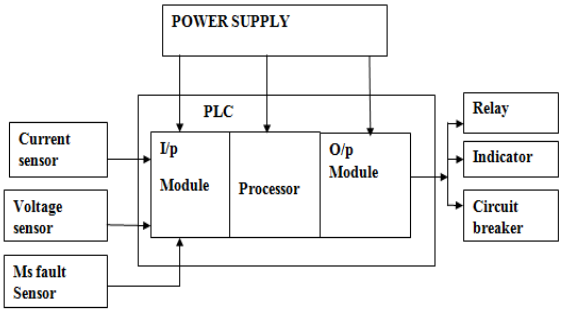


Figure1. Block diagram of PLC based power distribution control system

5. Software description of Simatic Siemens S7- 200

The Micro PLC SIMATIC S7-200 is truly in a class of its own: it's both compact and highly powerful especially in relation to its real-time response it's fast, features great communications options and comes with really easy to operate software and hardware. But there's more to it than that: the Micro PLC SIMATIC S7-200 has a consistently modular design for customized solutions which aren't too large for the present but open-ended enough to be expanded anytime in the future. All this makes the SIMATIC S7-200 a real economic alternative in open-loop control for the lower performance range. For any applications in automation engineering that constantly

depend on innovation and optimum customer benefit SIMATIC S7-200 delivers consistently economical solutions. The entire system family features are

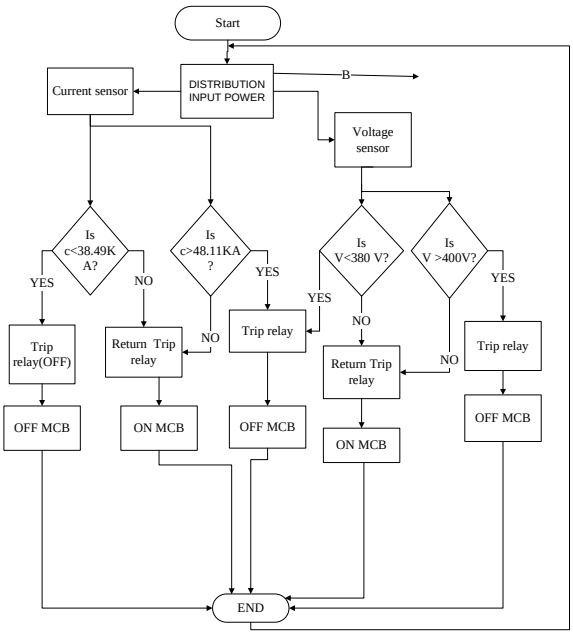
• Powerful performance,
• Optimum modularity and
• Open communications.

In addition, the SIMATIC S7-200 programming tool makes our job even easier: the Micro PLC is very easy to program allowing fast and easy realization of applications and the add-on libraries for the software accelerate and facilitate our work even more. Micro PLC has been in successful use in millions of applications around the world in both stand-alone solutions and networks.

Advantage of Simatic S7-200

- Connectivity,
- modularity,
- compact:
- So small
- Powerful

6. Flow chart of power distribution



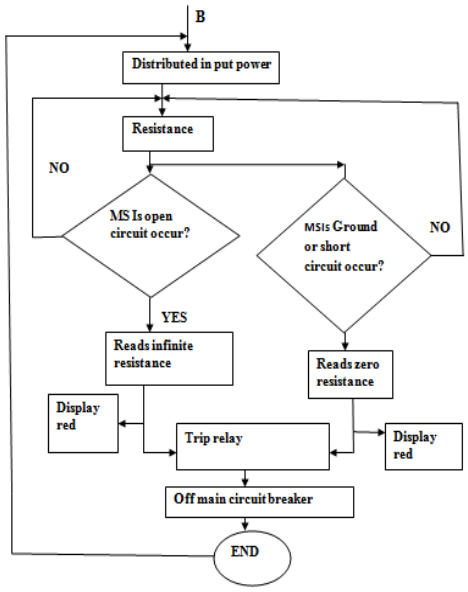


Figure2. Flow chart of the proposed system

7. Result and Discussion

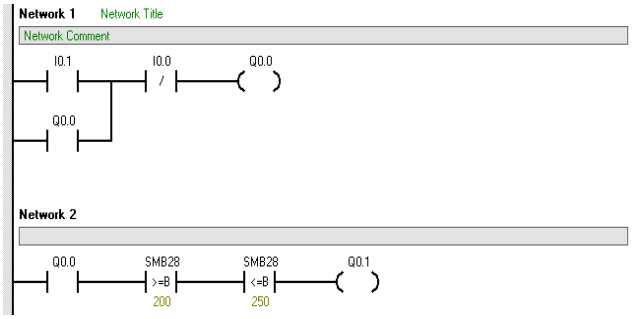
In this project we have used some devices to control the occurrence of fault in power distribution system these are sensors (voltage sensor, current sensor and megger sensor) which are connected to the input of the controller. And actuators (relay, indicator and main circuit breaker) which are connect to the output of the controller. The sensor are input devices that senses the present condition whether there is a fault they sends input signal to the controller but not only for the existence of fault also sense for return of the system(process) to its normal set value or range its normal operation. The actuator are output devices that detect the present condition whether there is a fault they receive output signal from the controller and provide response for the command but not only for the existence of fault also detect for return of the system(process) to its normal set value or range its normal operation.
Simatic 200 is a type of plc in which its maximum range is 250. In our project 200 represents for 380 volt and 250 represents for 400volt.

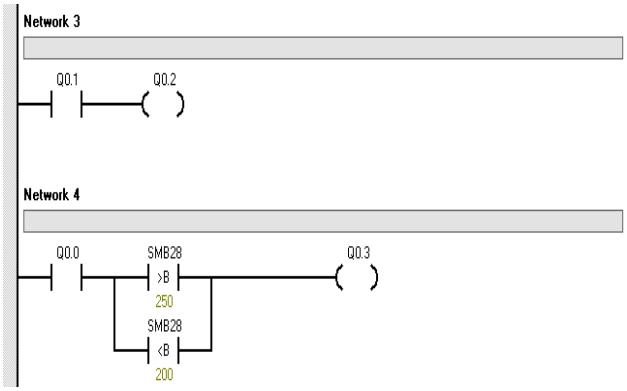
Network description

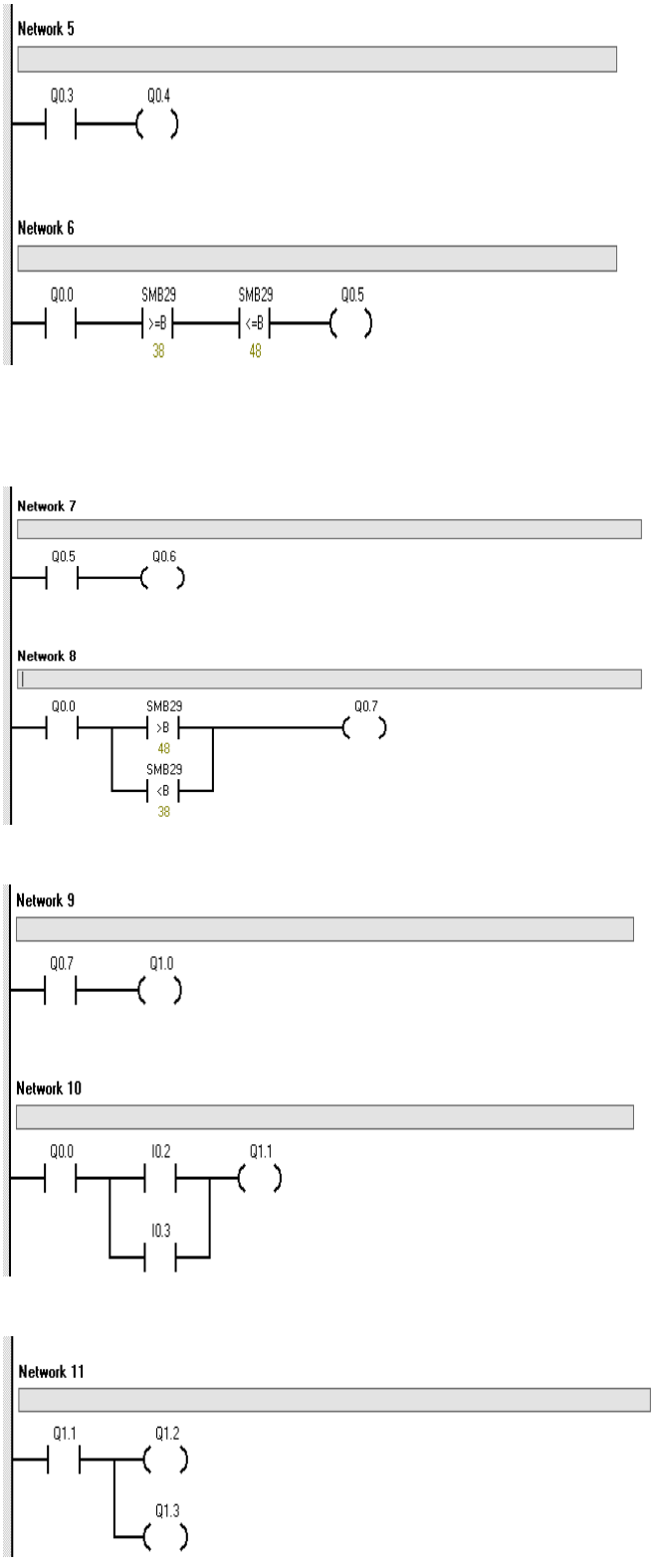
Network1: contains main start and stop push button with energize coil.
Network2: contains energize coil, code for voltage sensor and relay output of voltage sensor during normal ON start condition.
Network3: contains relay output of voltage sensor which is input to main circuit breaker during normal ON start condition.

Network4: contains energize coil, code voltage sensor (comparator) relay output of voltage sensor during under/over voltage fault condition.
Network5: contains relay output of voltage sensor which is input to the main circuit breaker during under/over voltage fault condition.
Network6: contains energize coil, code for current sensor (comparator) and relay output of current sensor during normal ON start condition.
Network7: contains relay output of current sensor which is input to the main circuit breaker during normal ON start condition.
Network8: contains energize coil, code for current sensor (comparator) and relay output of current sensor during under/over current fault condition.
Network9: contains relay output of current sensor which is input to the main circuit breaker during under/over current fault condition.
Network10: contains energize coil, megger sensor (comparator) relay output of megger sensor during open/short circuit fault condition.
Network11: contains relay output of megger sensor which is input to the main circuit breaker and indicator during open/short circuit fault condition.

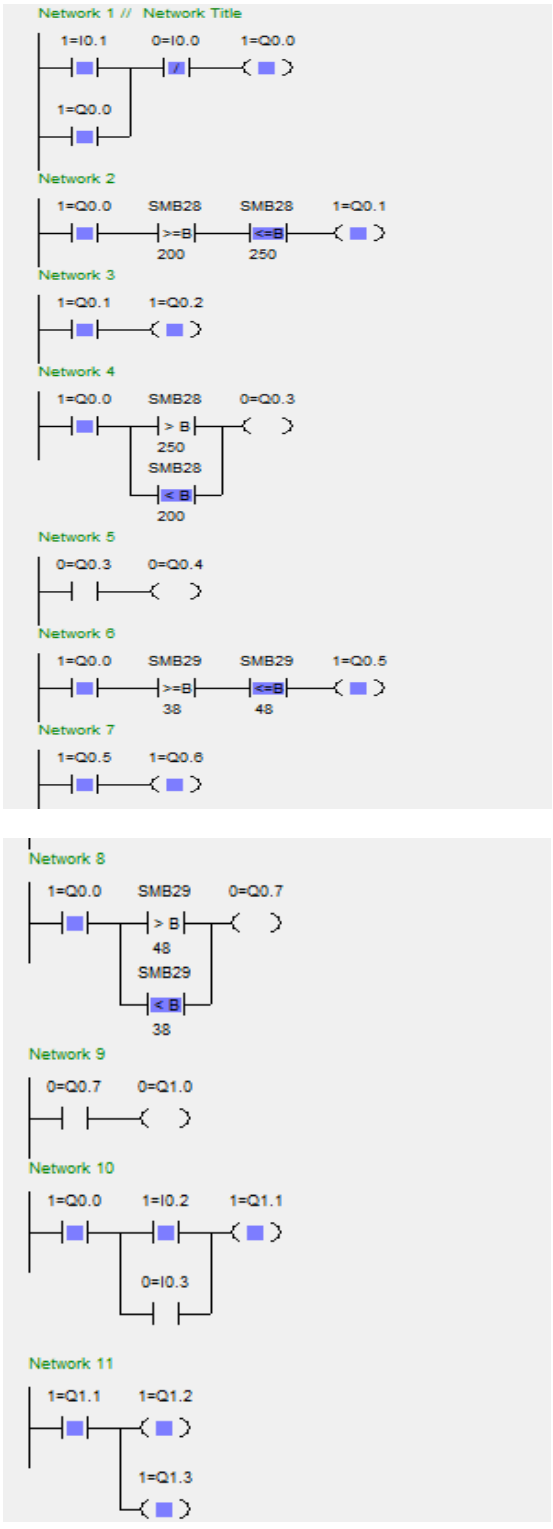
Symbol	Description	Symbol	Description
Q 0.0	Starting internal coil	**I 0.0**	Main Stop push button
Q 0.1	Relay for voltage normal return ON Operation	**I 0.1**	Main Star push button
Q 0.2	Main circuit breaker voltage for normal return ON Operation	**I 0.2**	High resistance sensor
Q 0.3	Trip Relay(OFF) for under or over voltage condition	**I 0.3**	Low resistance sensor
Q 0.4	Main circuit breaker OFF under or over voltage condition	SMB28	Code for under / over voltage sensor
Q 0.5	Relay for current normal return ON operation	SMB29	Code for under /over current sensor
Q O.6	Main circuit breaker current for normal return ON operation		
Q 0.7	Trip Relay (OFF)for under or over current condition		
Q 1.0	Main circuit breaker OFF for under or over current condition		
Q 1.1	Trip relay (OFF) when short , Ground or open circuit occur		
Q 1.2	Main circuit breaker OFF when short, Ground or open circuit occur		
Q 1.3	Indicator during fault occur		



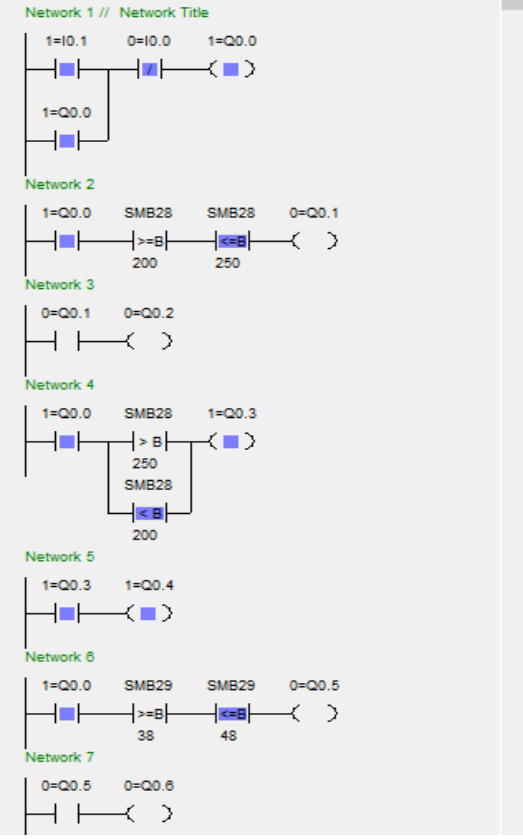


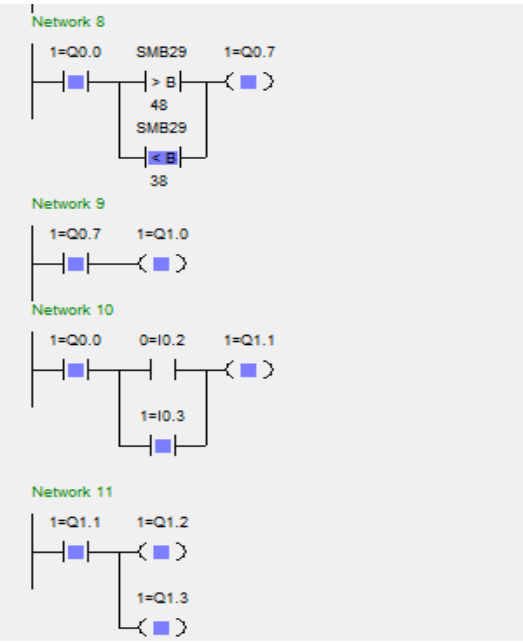


Condition1: voltage and current at normal and R high



Condition2: all parametrs are out of range





When main start push button is press internal coil ($Q_{0.0}$) is energized and SMB28, relay output ($Q_{0.1}$) and main circuit breaker ($Q_{O.2}$) are first at normal ON start condition. If under/over voltage fault is occur voltage sensor (SMB28) sends signal to the relay ($Q_{0.3}$) that connected to the output of voltage sensor which operated during voltage fault condition and the relay trip by receiving signal from voltage sensor and send signal to the main circuit breaker ($Q_{0.4}$) that connected to output of the relay operated during voltage fault condition to made OFF the control circuit. As soon the range of voltage returned to its normal operation set value the voltage sensor send signal to the energized relay($Q_{O.1}$) that connected to its output at normal return operation and the relay send signal to main circuit breaker($Q_{0.2}$) which made restart(ON) the control circuit. Next relay output ($Q_{O.5}$) and main circuit breaker ($Q_{O.6}$) are at normal ON start condition, if under/over current fault is occur current sensor (SMB29) sends signal to the relay ($Q_{0.7}$) that connected to the output of current sensor which operated during current fault condition and the relay trip by receiving signal from current sensor and send signal to the main circuit breaker($Q_{1.0}$) that connected to output of the relay operated during current fault condition to made OFF the control circuit. As soon the range of the current returned to its normal operation set value the current sensor send signal to the energized relay($Q_{O.5}$) that connected to its output at normal return operation and the relay send signal to main circuit breaker($Q_{0.6}$) made restart(ON) the control circuit. When ground, short circuit or open circuit is occur megger sensor send signal to the relay ($Q_{1.1}$) that connected to its output which operated during these fault conditions and, the relay trip and send signal to the and indicator ($Q_{1.3}$) and main circuit breaker ($Q_{1.2}$) which connected to its output that operated during ground, short circuit or open circuit which made OFF the control circuit.

8. Conclusion

PLC based power distribution control system is an important device or system to keep or to control automatically without interfering of human hand in both conditions (normal or fault) the power distribution at the state of comfort for human being. This is consist of measurement system such as voltage sensor, current sensor and megger sensor which are inputs of the system and, relay, circuit breaker and indicator which are out puts of the system and also PLC which is controller of the system. The input measurement are devices that sends input signal to the controller and output measurements are devices that receive output signal from the controller. The parameters that we need to control are over or under voltage fault, over or under current fault and open or short circuit fault. The importance of controlling the faults that explained above is for personal safety, for electrical equipments safety, to deliver qualified power for customer, to minimize power consumption and unexpected cost of electric power or energy, to improve power efficiency and to have environmental protection; generally the main

objective of our project is to substitute manually operation control system with automatically operation control system in Aksum University power distribution station.

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